

Relationships Between Flow, Water Temperature, And Exports In  
The San Joaquin River Delta And The Rate That Adult Merced  
River Hatchery Fall-Run Chinook Salmon With Coded-Wire-Tags  
Were Recovered In The Central Valley Escapement And The  
Ocean Fisheries

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## INTRODUCTION

A total of 158 releases of juvenile salmon marked with coded-wire tags (CWT) were released in the San Joaquin River between Mossdale and Dos Reis between 1982 and 2006. Smolt survival rates have been estimated for the Vernalis Adaptive Management Plan studies as a function of the number of recoveries with trawls at Chipps Island, Jersey Point, and/or Antioch as described in the Annual Technical Reports by the San Joaquin River Group Authority. The trawl based absolute survival estimates, which are called “Differential Recovery Rates” in the Annual Technical Reports, are computed as the combined trawl recovery rate for the upstream release group of CWT smolts (Mossdale or Dos Reis) divided by the combined trawl recovery rate for the downstream release group of CWT smolts at Jersey Point. Paired upstream and downstream releases have been made since 1989.

An index of smolt survival can also be made by estimating the total number of CWT salmon that returned to spawn in the inland escapement or were caught in the ocean fisheries divided by the number of juvenile salmon released. This index of survival, which is called the Adult Recovery Rate in this report, has two advantages over the trawl based absolute survival estimates used in the VAMP studies. First, paired releases are unnecessary and so this index provides more estimates, particularly from 1982 to 1988, when no physical Head of the Old River Barrier was installed and there was a large range in Delta export rates and flows at Vernalis. Second, the Adult Recovery Rate reflects survival to the adult life stage, not just juvenile survival from point A (e.g., Mossdale) to point B (e.g., Jersey Point). This would be important if smolts survived to Chipps Island, but were so diseased or otherwise in poor health that they died soon after. However, there is one major disadvantage in that Adult Survival Rate is affected by the survival of the salmon in the ocean as well as the conditions in the Delta. This disadvantage was minimized in the analyses reported here by excluding the estimates during years when ocean conditions were poor as indicated by an index of ocean conditions developed by Wells and others (2007).

## METHODS

The methods used to estimate the adult CWT inland and ocean recoveries are described in Mesick et al. (2009). The estimated CWT recoveries for the releases of smolt-sized Merced and Feather River Hatchery salmon that marked with coded-wire tags and released in the San Joaquin River between Mossdale and Dos Reis between 1982 and 2006 were used for these analyses. The Adult Survival Rate estimates were made by dividing the total number of CWT salmon that returned to spawn in the inland escapement and were caught in the ocean fisheries divided by the number of juvenile salmon released for each CWT code. Excel Pivot Tables were used to estimate the total number of recoveries for each CWT release from all inland and ocean sampling sites and all adult run years. The CWT Adult Recovery Rate estimates are presented in Table 1.

The effect of ocean conditions on the survival evaluations was minimized by excluding the estimates during years when ocean conditions were poor as indicated by an index of

ocean conditions developed by Wells and others (2008). The survival rates for the 158 CWT smolt releases were relatively low when the Well's ocean index was less than -0.4 (Figure 1). Therefore, smolt survival estimates that correspond to years when the Well's ocean index was less than -0.4 were excluded from evaluations of flows, exports, and water temperatures in the Delta.

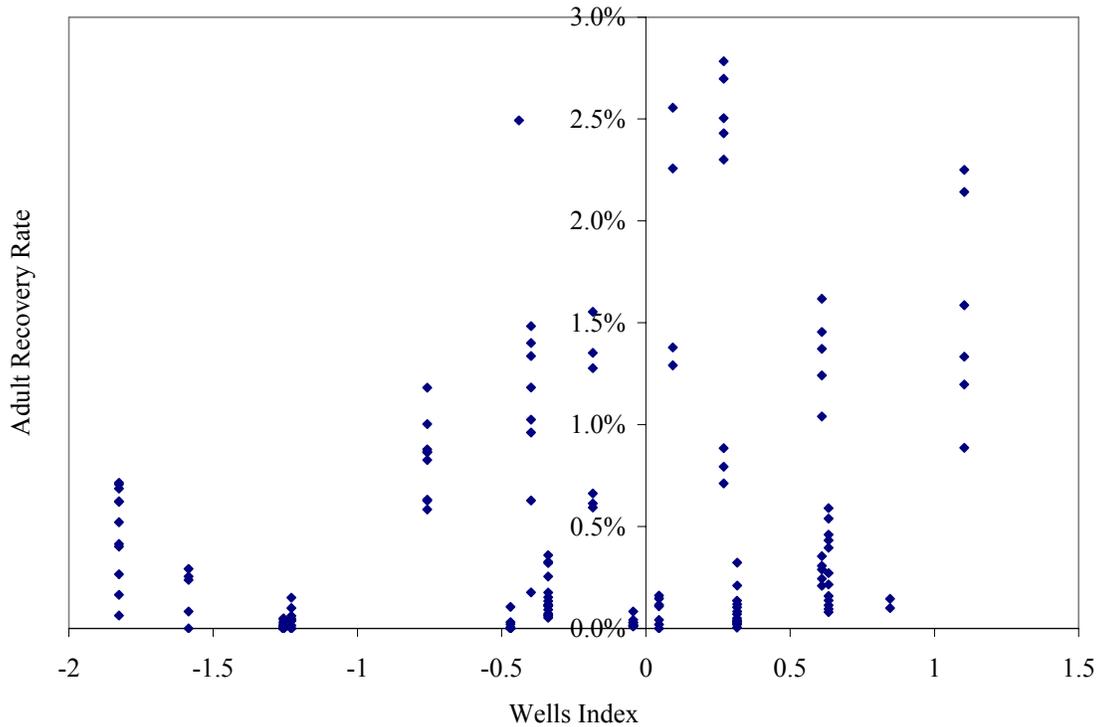


Figure 1. The relationship between the Adult Recovery Rate and the Wells and others (2008) ocean conditions index for juvenile CWT releases made in the San Joaquin River between Mossdale and Dos Reis from 1983 to 2004.

The estimates of flow and water temperature in the San Joaquin River at Mossdale were made by AD Consultants and others (2009). The estimates of the total combined Delta exports (SWP, CVP, and CCC) are from the California Department of Water Resources Dayflow model output available at <http://www.water.ca.gov/dayflow/output/>.

The relationships were segregated into two groups: releases made when there was no Head of the Old River Barrier (HORB) installed and releases made when there was a HORB installed. The HORB affected smolt survival by minimizing the number of smolts that migrated into the Old River toward the Federal and State pumping facilities and by keeping a majority of the San Joaquin flow in the mainstem channel.

## RESULTS

The relationships between the Adult Recovery Rates and flows at Mossdale (Figure 2), Delta export rates (Figures 3 and 4), and water temperature at Mossdale (Figure 5)

suggest that managing flows that exceed 1,350 cfs, exports that exceed 1,740 cfs, and water temperatures below 71 degrees Fahrenheit has little effect on salmon smolt survival when no physical HORB is installed. It is likely that without the HORB, flow cannot substantially reduce the impacts of the poor water quality in the Deepwater Ship Channel. In the Old River, export levels that exceed 1,740 cfs probably result in high rates of entrainment and indirect mortality associated with exports (e.g., predation near the intakes).

When the HORB was installed, the results of the survival analyses with the Adult Recovery Rates are similar to those with the juvenile Differential Recovery Rates described in the VAMP Annual Technical Reports. Both sets of estimates suggest that there is a positive association between Delta flow (Figure 2) and smolt survival (Figure 3) when the HORB was installed (Newman 2008). The Adult Recovery Rates when the HORB was installed were inversely correlated with water temperatures at Mossdale (Figure 5) as expected based on the EPA (2003) criteria.

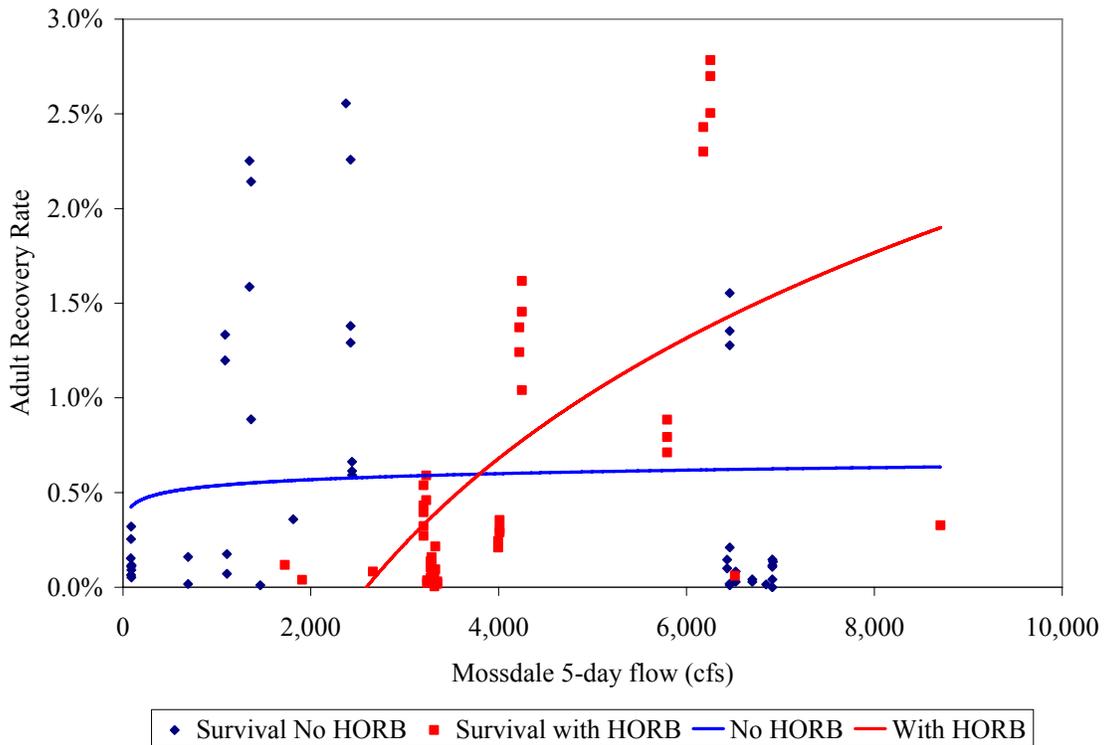


Figure 2. The relationship between the Adult Recovery Rate and the 5-day mean flow in the San Joaquin River at Mossdale (AD Consultants and others 2009) following the juvenile release date with and without the Head of the Old River Barrier (HORB). Excel trendlines (logarithmic regressions) are shown for the estimates with and without the HORB.

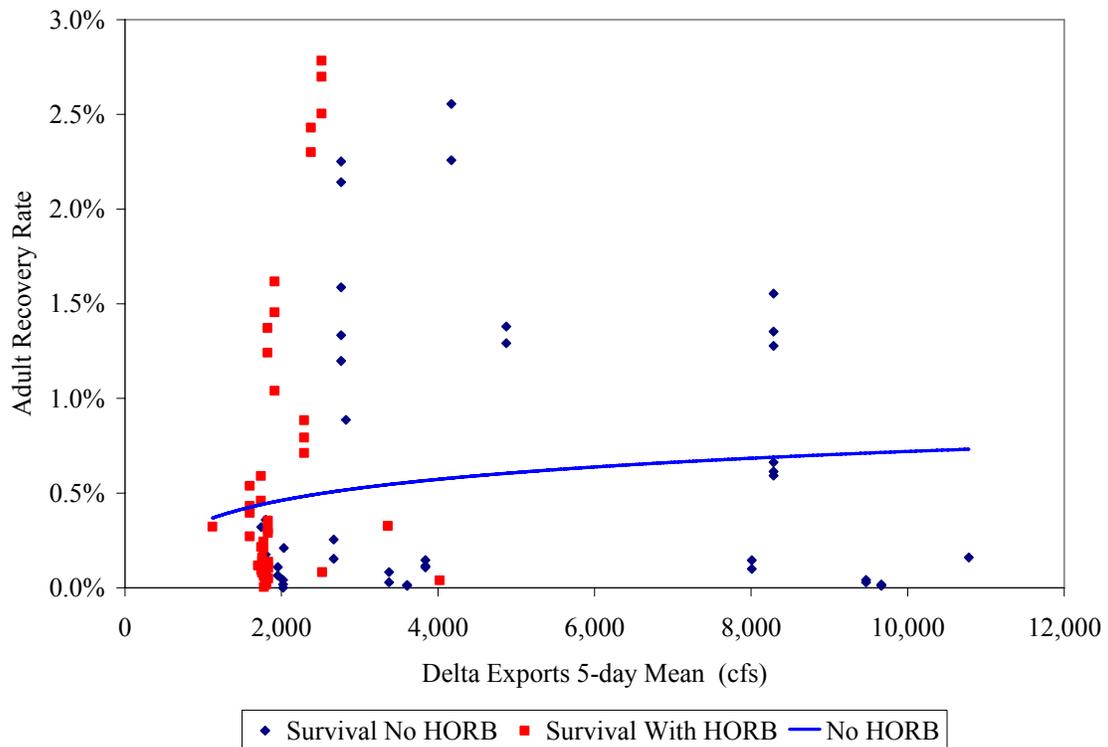


Figure 3. The relationship between the Adult Recovery Rate and the 5-day mean Delta Export Rate (DWR Dayflow) following the juvenile release date with and without the Head of the Old River Barrier (HORB). Excel trendline (logarithmic regression) is shown for the estimates without the HORB.

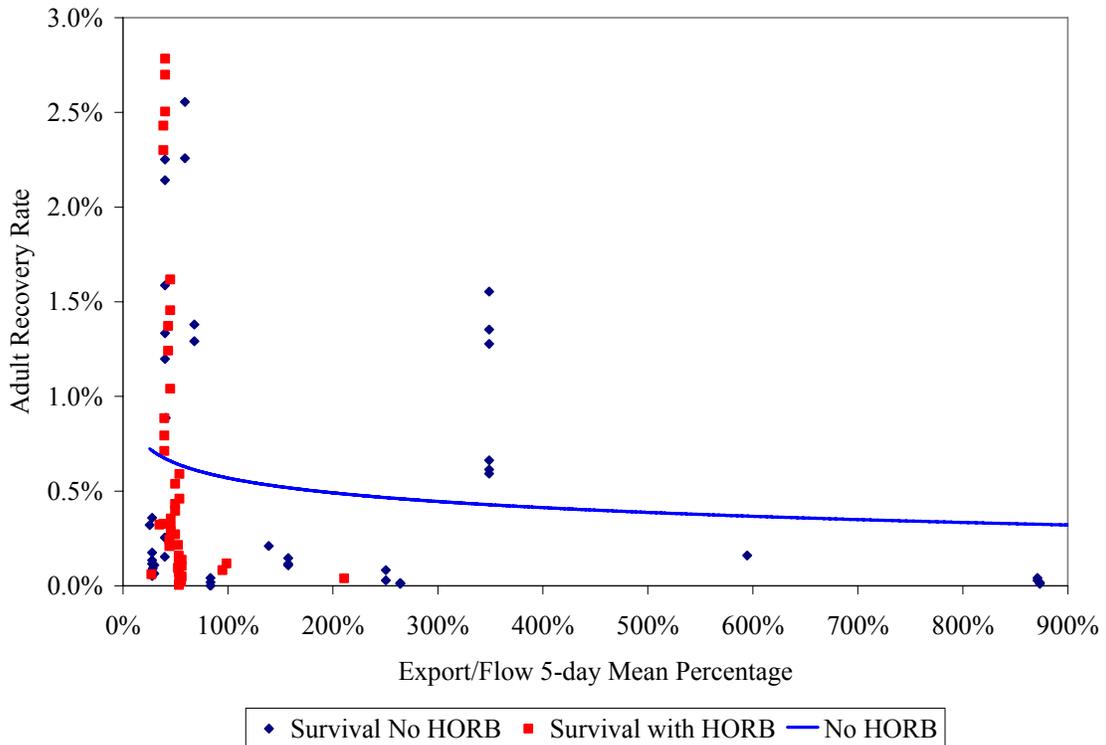


Figure 4. The relationship between the Adult Recovery Rate and the 5-day mean ratio of Delta Export Rates (DWR Dayflow) to the Mossdale Flow (AD Consultants and others 2009) following the juvenile release date with and without the Head of the Old River Barrier (HORB). Excel trendline (logarithmic regression) is shown for the estimates without the HORB.

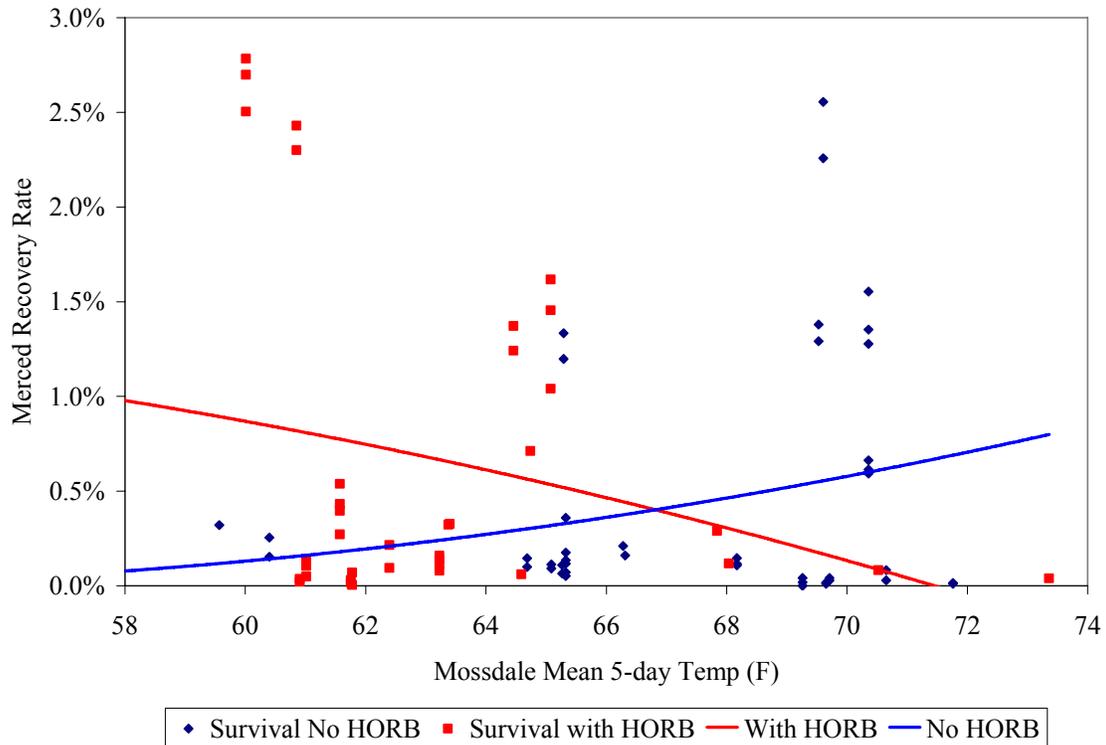


Figure 4. The relationship between the Adult Recovery Rate and the 5-day mean water temperature (Fahrenheit) at Mossdale (AD Consultants and others 2009) following the juvenile release date with and without the Head of the Old River Barrier (HORB). Excel trendlines (2nd order polynomial regressions) are shown for the estimates with and without the HORB.

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Wells, B.K., J.C. Field, J.A. Thayer, C.B. Grimes, S. J. Bograd, W.J. Sydeman, F. B. Schwing, and R. Hewitt. 2008. Untangling the relationships among climate, prey and top predators in an ocean ecosystem. *Marine Ecology Progress Series* 364:15-29.

Table 1. The Adult Recovery Rate estimates for all Merced River Hatchery (MRH) and Feather River Hatchery (FRH) coded-wire-tag (CWT) releases in the San Joaquin River between Mossdale and Dos Reis from 1982 to 2005.

| <u>REARING LOCATION</u> | <u>CWT CODE</u> | <u>RELEASE LOCATION</u> | <u>Total Released</u> | <u>DATE RELEASED</u> | <u>Adult Recovery Rate</u> | <u>Wells Ocean Index</u> | <u>Mossdale 5-day Mean Flows</u> | <u>Mossdale 5-day Mean Temp</u> | <u>Exports 5-day Mean</u> | <u>Export/Mossdale Flow</u> | <u>HORB</u> |
|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|----------------------------------|---------------------------------|---------------------------|-----------------------------|-------------|
| MRH                     | 062545          | DOS REIS ROAD           | 50,190                | 4/29/97              | 1.1827%                    | -0.3983                  | 5,900                            | 62.0                            | 2,639                     | 0.4473                      | Yes         |
| MRH                     | 062546          | DOS REIS ROAD           | 54,810                | 4/29/97              | 0.9618%                    | -0.3983                  | 5,900                            | 62.0                            | 2,639                     | 0.4473                      | Yes         |
| MRH                     | 062548          | DOS REIS ROAD           | 51,294                | 5/8/97               | 0.6277%                    | -0.3983                  | 6,052                            | 65.7                            | 2,833                     | 0.4681                      | Yes         |
| MRH                     | 062550          | DOS REIS ROAD           | 51,671                | 5/27/97              | 0.1770%                    | -0.3983                  | 3,448                            | 71.7                            | 6,875                     | 1.9937                      | Yes         |
| MRH                     | 0601060914      | DURHAM FERRY            | 25,016                | 4/28/00              | 0.8841%                    | 0.2699                   | 5,794                            | 17.6                            | 2,289                     | 0.3951                      | Yes         |
| MRH                     | 0601060915      | DURHAM FERRY            | 28,296                | 4/28/00              | 0.7933%                    | 0.2699                   | 5,794                            | 17.6                            | 2,289                     | 0.3951                      | Yes         |
| MRH                     | 0601110814      | DURHAM FERRY            | 25,218                | 4/28/00              | 0.7120%                    | 0.2699                   | 5,794                            | 64.7                            | 2,289                     | 0.3951                      | Yes         |
| MRH                     | 060401          | DURHAM FERRY            | 25,987                | 4/17/00              | 2.6981%                    | 0.2699                   | 6,255                            | 60.0                            | 2,512                     | 0.4016                      | Yes         |
| MRH                     | 060402          | DURHAM FERRY            | 25,939                | 4/17/00              | 2.7836%                    | 0.2699                   | 6,255                            | 60.0                            | 2,512                     | 0.4016                      | Yes         |
| MRH                     | 064401          | MOSSDALE                | 26,399                | 4/18/00              | 2.4301%                    | 0.2699                   | 6,180                            | 60.9                            | 2,376                     | 0.3845                      | Yes         |
| MRH                     | 064402          | MOSSDALE                | 25,977                | 4/18/00              | 2.3006%                    | 0.2699                   | 6,180                            | 60.9                            | 2,376                     | 0.3845                      | Yes         |
| MRH                     | 064563          | DURHAM FERRY            | 26,482                | 4/17/00              | 2.5045%                    | 0.2699                   | 6,255                            | 60.0                            | 2,512                     | 0.4016                      | Yes         |
| MRH                     | 064429          | DURHAM FERRY            | 25,802                | 4/30/01              | 1.0402%                    | 0.6102                   | 4,248                            | 65.1                            | 1,912                     | 0.4501                      | Yes         |
| MRH                     | 064430          | DURHAM FERRY            | 25,105                | 4/30/01              | 1.6178%                    | 0.6102                   | 4,248                            | 65.1                            | 1,912                     | 0.4501                      | Yes         |
| MRH                     | 064431          | DURHAM FERRY            | 24,725                | 4/30/01              | 1.4553%                    | 0.6102                   | 4,248                            | 65.1                            | 1,912                     | 0.4501                      | Yes         |
| MRH                     | 064432          | MOSSDALE                | 25,838                | 5/1/01               | 1.2419%                    | 0.6102                   | 4,221                            | 64.5                            | 1,822                     | 0.4316                      | Yes         |
| MRH                     | 064433          | MOSSDALE                | 26,107                | 5/1/01               | 1.3717%                    | 0.6102                   | 4,221                            | 64.5                            | 1,822                     | 0.4316                      | Yes         |
| MRH                     | 064436          | DURHAM FERRY            | 25,428                | 5/7/01               | 0.2894%                    | 0.6102                   | 4,010                            | 67.8                            | 1,826                     | 0.4554                      | Yes         |
| MRH                     | 064437          | DURHAM FERRY            | 25,298                | 5/7/01               | 0.3545%                    | 0.6102                   | 4,010                            | 17.6                            | 1,826                     | 0.4554                      | Yes         |
| MRH                     | 064438          | DURHAM FERRY            | 25,454                | 5/7/01               | 0.3075%                    | 0.6102                   | 4,010                            | 17.6                            | 1,826                     | 0.4554                      | Yes         |
| MRH                     | 064439          | MOSSDALE                | 25,542                | 5/8/01               | 0.2097%                    | 0.6102                   | 3,996                            | 17.6                            | 1,770                     | 0.4429                      | Yes         |
| MRH                     | 064440          | MOSSDALE                | 25,695                | 5/8/01               | 0.2441%                    | 0.6102                   | 3,996                            | 17.6                            | 1,770                     | 0.4429                      | Yes         |

| <u>REARING LOCATION</u> | <u>CWT CODE</u> | <u>RELEASE LOCATION</u> | <u>Total Released</u> | <u>DATE RELEASED</u> | <u>Adult Recovery Rate</u> | <u>Wells Ocean Index</u> | <u>Mosssdale 5-day Mean Flows</u> | <u>Mosssdale 5-day Mean Temp</u> | <u>Exports 5-day Mean</u> | <u>Export/Mosssdale Flow</u> | <u>HORB</u> |
|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|-----------------------------------|----------------------------------|---------------------------|------------------------------|-------------|
| MRH                     | 064457          | MOSSDALE                | 25,637                | 4/19/02              | 0.5900%                    | 0.6325                   | 3,228                             | 17.6                             | 1,738                     | 0.5384                       | Yes         |
| MRH                     | 064458          | MOSSDALE                | 26,050                | 4/19/02              | 0.4601%                    | 0.6325                   | 3,228                             | 17.6                             | 1,738                     | 0.5384                       | Yes         |
| MRH                     | 064470          | DURHAM FERRY            | 25,831                | 4/25/02              | 0.1370%                    | 0.6325                   | 3,287                             | 63.2                             | 1,753                     | 0.5333                       | Yes         |
| MRH                     | 064471          | DURHAM FERRY            | 25,128                | 4/18/02              | 0.2717%                    | 0.6325                   | 3,200                             | 61.6                             | 1,595                     | 0.4984                       | Yes         |
| MRH                     | 064472          | DURHAM FERRY            | 26,447                | 4/18/02              | 0.5386%                    | 0.6325                   | 3,200                             | 61.6                             | 1,595                     | 0.4984                       | Yes         |
| MRH                     | 064473          | DURHAM FERRY            | 25,078                | 4/18/02              | 0.4324%                    | 0.6325                   | 3,200                             | 61.6                             | 1,595                     | 0.4984                       | Yes         |
| MRH                     | 064474          | DURHAM FERRY            | 25,997                | 4/18/02              | 0.3959%                    | 0.6325                   | 3,200                             | 61.6                             | 1,595                     | 0.4984                       | Yes         |
| MRH                     | 064475          | DURHAM FERRY            | 25,809                | 4/25/02              | 0.1589%                    | 0.6325                   | 3,287                             | 63.2                             | 1,753                     | 0.5333                       | Yes         |
| MRH                     | 064476          | DURHAM FERRY            | 25,939                | 4/25/02              | 0.0796%                    | 0.6325                   | 3,287                             | 63.2                             | 1,753                     | 0.5333                       | Yes         |
| MRH                     | 064477          | DURHAM FERRY            | 25,518                | 4/25/02              | 0.1137%                    | 0.6325                   | 3,287                             | 63.2                             | 1,753                     | 0.5333                       | Yes         |
| MRH                     | 064478          | MOSSDALE                | 26,076                | 4/26/02              | 0.2156%                    | 0.6325                   | 3,325                             | 62.4                             | 1,743                     | 0.5242                       | Yes         |
| MRH                     | 064479          | MOSSDALE                | 25,716                | 4/26/02              | 0.0944%                    | 0.6325                   | 3,325                             | 62.4                             | 1,743                     | 0.5242                       | Yes         |
| MRH                     | 060282          | DURHAM FERRY            | 25,862                | 4/21/03              | 0.1039%                    | 0.3156                   | 3,276                             | 61.0                             | 1,833                     | 0.5595                       | Yes         |
| MRH                     | 060283          | DURHAM FERRY            | 27,415                | 4/21/03              | 0.0491%                    | 0.3156                   | 3,276                             | 61.0                             | 1,833                     | 0.5595                       | Yes         |
| MRH                     | 062742          | DURHAM FERRY            | 25,457                | 4/21/03              | 0.1367%                    | 0.3156                   | 3,276                             | 61.0                             | 1,833                     | 0.5595                       | Yes         |
| MRH                     | 062743          | MOSSDALE                | 26,970                | 4/22/03              | 0.0228%                    | 0.3156                   | 3,239                             | 60.9                             | 1,795                     | 0.5541                       | Yes         |
| MRH                     | 062745          | DURHAM FERRY            | 26,122                | 5/28/03              | 0.0397%                    | 0.3156                   | 1,909                             | 73.4                             | 4,022                     | 2.1071                       | Yes         |
| MRH                     | 062746          | DURHAM FERRY            | 26,652                | 4/28/03              | 0.0184%                    | 0.3156                   | 3,349                             | 61.8                             | 1,805                     | 0.5389                       | Yes         |
| MRH                     | 062747          | DURHAM FERRY            | 26,062                | 4/28/03              | 0.0303%                    | 0.3156                   | 3,349                             | 61.8                             | 1,805                     | 0.5389                       | Yes         |
| MRH                     | 062748          | MOSSDALE                | 26,409                | 4/22/03              | 0.0360%                    | 0.3156                   | 3,239                             | 60.9                             | 1,795                     | 0.5541                       | Yes         |
| MRH                     | 062749          | MOSSDALE                | 26,031                | 4/29/03              | 0.0703%                    | 0.3156                   | 3,316                             | 61.8                             | 1,775                     | 0.5352                       | Yes         |
| MRH                     | 062750          | MOSSDALE                | 26,064                | 4/29/03              | 0.0038%                    | 0.3156                   | 3,316                             | 61.8                             | 1,775                     | 0.5352                       | Yes         |
| MRH                     | 062752          | DURHAM FERRY            | 26,338                | 4/22/04              | 0.1061%                    | -0.4691                  | 3,126                             | 63.4                             | 1,696                     | 0.5426                       | Yes         |
| MRH                     | 062753          | DURHAM FERRY            | 26,321                | 4/22/04              | 0.0000%                    | -0.4691                  | 3,126                             | 63.4                             | 1,696                     | 0.5426                       | Yes         |

| <u>REARING LOCATION</u> | <u>CWT CODE</u> | <u>RELEASE LOCATION</u> | <u>Total Released</u> | <u>DATE RELEASED</u> | <u>Adult Recovery Rate</u> | <u>Wells Ocean Index</u> | <u>Mossdale 5-day Mean Flows</u> | <u>Mossdale 5-day Mean Temp</u> | <u>Exports 5-day Mean</u> | <u>Export/Mossdale Flow</u> | <u>HORB</u> |
|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|----------------------------------|---------------------------------|---------------------------|-----------------------------|-------------|
| MRH                     | 062754          | DURHAM FERRY            | 25,920                | 4/22/04              | 0.0311%                    | -0.4691                  | 3,126                            | 63.4                            | 1,696                     | 0.5426                      | Yes         |
| MRH                     | 062755          | DURHAM FERRY            | 25,993                | 4/22/04              | 0.0000%                    | -0.4691                  | 3,126                            | 63.4                            | 1,696                     | 0.5426                      | Yes         |
| MRH                     | 064582          | MOSSDALE                | 25,749                | 4/23/04              | 0.0000%                    | -0.4691                  | 3,168                            | 64.7                            | 1,790                     | 0.5650                      | Yes         |
| MRH                     | 064583          | MOSSDALE                | 25,703                | 4/23/04              | 0.0059%                    | -0.4691                  | 3,168                            | 64.7                            | 1,790                     | 0.5650                      | Yes         |
| MRH                     | 064670          | MOSSDALE                | 26,238                | 4/23/04              | 0.0209%                    | -0.4691                  | 3,168                            | 64.7                            | 1,790                     | 0.5650                      | Yes         |
| FRH                     | 0601140303      | STEWART ROAD-FRH        | 53,997                | 4/24/92              | 0.0609%                    | -1.2290                  | 1,221                            | 68.8                            | 1,375                     | 1.1265                      | Yes         |
| FRH                     | 0601140304      | STEWART ROAD-FRH        | 52,628                | 4/24/92              | 0.0380%                    | -1.2290                  | 1,221                            | 68.8                            | 1,375                     | 1.1265                      | Yes         |
| FRH                     | 063131          | STEWART ROAD-FRH        | 54,363                | 5/4/92               | 0.0000%                    | -1.2290                  | 1,243                            | 72.3                            | 3,151                     | 2.5344                      | Yes         |
| FRH                     | 063132          | STEWART ROAD-FRH        | 52,164                | 5/4/92               | 0.0000%                    | -1.2290                  | 1,243                            | 72.3                            | 3,151                     | 2.5344                      | Yes         |
| FRH                     | 063134          | STEWART ROAD-FRH        | 54,036                | 5/12/92              | 0.0144%                    | -1.2290                  | 848                              | 73.9                            | 2,117                     | 2.4962                      | Yes         |
| FRH                     | 063133          | STEWART ROAD-FRH        | 53,880                | 5/12/92              | 0.0000%                    | -1.5854                  | 848                              | 73.9                            | 2,117                     | 2.4962                      | Yes         |
| FRH                     | 0601140404      | STEWART ROAD-FRH        | 55,448                | 4/26/94              | 0.3229%                    | 0.3167                   | 3,201                            | 63.4                            | 1,119                     | 0.3496                      | Yes         |
| FRH                     | 063141          | STEWART ROAD-FRH        | 53,121                | 5/2/94               | 0.1183%                    | 0.3167                   | 1,724                            | 68.0                            | 1,702                     | 0.9871                      | Yes         |
| FRH                     | 063143          | STEWART ROAD-FRH        | 54,537                | 5/9/94               | 0.0827%                    | 0.3167                   | 2,661                            | 70.5                            | 2,522                     | 0.9478                      | Yes         |
| FRH                     | 0601060204      | DOS REIS ROAD-FRH       | 51,271                | 5/16/96              | 0.3267%                    | -0.3387                  | 8,704                            | 63.4                            | 3,359                     | 0.3859                      | Yes         |
| FRH                     | 0601060206      | DOS REIS ROAD-FRH       | 51,730                | 5/9/96               | 0.0611%                    | -0.3387                  | 6,516                            | 64.6                            | 1,776                     | 0.2726                      | Yes         |
| FRH                     | 0601060302      | STEWART ROAD-FRH        | 26,784                | 4/28/97              | 1.4009%                    | -0.3983                  | 6,018                            | 62.2                            | 2,531                     | 0.4206                      | Yes         |
| FRH                     | 0601060303      | STEWART ROAD-FRH        | 28,334                | 4/28/97              | 1.3364%                    | -0.3983                  | 6,018                            | 62.2                            | 2,531                     | 0.4206                      | Yes         |
| FRH                     | 0601060304      | DOS REIS ROAD-FRH       | 27,059                | 4/29/97              | 1.4835%                    | -0.3983                  | 5,900                            | 62.0                            | 2,639                     | 0.4473                      | Yes         |
| FRH                     | 0601060305      | DOS REIS ROAD-FRH       | 26,695                | 4/29/97              | 1.0251%                    | -0.3983                  | 5,900                            | 62.0                            | 2,639                     | 0.4473                      | Yes         |
| MRH                     | 064628          | SAN JOAQ.R,BELOW OLD    | 50,765                | 4/24/82              | 2.4937%                    | -0.4400                  | 27,939                           | 63.6                            | 10,070                    | 0.3604                      | No          |
| MRH                     | 064658          | DOS REIS ROAD           | 226,554               | 5/29/86              | 2.5555%                    | 0.0930                   | 7,066                            | 69.6                            | 4,170                     | 0.5901                      | No          |
| MRH                     | 064659          | STEWART ROAD            | 52,905                | 5/30/86              | 1.3794%                    | 0.0930                   | 7,158                            | 69.5                            | 4,873                     | 0.6808                      | No          |
| MRH                     | B61101          | DOS REIS ROAD           | 51,226                | 5/29/86              | 2.2579%                    | 0.0930                   | 7,066                            | 69.6                            | 4,170                     | 0.5901                      | No          |

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|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|-----------------------------------|----------------------------------|---------------------------|------------------------------|-------------|
| MRH                     | B61102          | STEWART ROAD            | 54,310                | 5/30/86              | 1.2912%                    | 0.0930                   | 7,158                             | 69.5                             | 4,873                     | 0.6808                       | No          |
| MRH                     | 064503          | STEWART ROAD            | 37,024                | 4/27/87              | 0.5928%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 064504          | STEWART ROAD            | 34,814                | 4/27/87              | 0.6134%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 064505          | STEWART ROAD            | 36,438                | 4/27/87              | 0.6623%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 064506          | DOS REIS ROAD           | 36,420                | 4/27/87              | 1.2776%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 064507          | DOS REIS ROAD           | 37,251                | 4/27/87              | 1.3525%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 064508          | DOS REIS ROAD           | 35,412                | 4/27/87              | 1.5538%                    | -0.1845                  | 2,375                             | 70.4                             | 8,288                     | 3.4891                       | No          |
| MRH                     | 0601110104      | STEWART ROAD            | 27,181                | 5/3/89               | 0.0185%                    | 0.0452                   | 2,424                             | 69.3                             | 2,020                     | 0.8333                       | No          |
| MRH                     | 0601110105      | STEWART ROAD            | 26,582                | 5/3/89               | 0.0000%                    | 0.0452                   | 2,424                             | 69.3                             | 2,020                     | 0.8333                       | No          |
| MRH                     | 0601110106      | STEWART ROAD            | 26,850                | 5/3/89               | 0.0410%                    | 0.0452                   | 2,424                             | 69.3                             | 2,020                     | 0.8333                       | No          |
| MRH                     | 0601110107      | DOS REIS ROAD           | 26,108                | 5/2/89               | 0.1088%                    | 0.0452                   | 2,438                             | 68.2                             | 3,838                     | 1.5743                       | No          |
| MRH                     | 0601110108      | DOS REIS ROAD           | 26,672                | 5/2/89               | 0.1460%                    | 0.0452                   | 2,438                             | 68.2                             | 3,838                     | 1.5743                       | No          |
| MRH                     | 0601110113      | DOS REIS ROAD           | 26,383                | 5/2/89               | 0.1156%                    | 0.0452                   | 2,438                             | 68.2                             | 3,838                     | 1.5743                       | No          |
| MRH                     | 0601110412      | DOS REIS ROAD           | 25,633                | 5/1/96               | 0.1345%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| MRH                     | 0601110413      | DOS REIS ROAD           | 29,192                | 5/1/96               | 0.3589%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| MRH                     | 0601110414      | DOS REIS ROAD           | 18,533                | 5/1/96               | 0.0716%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| MRH                     | 0601110415      | DOS REIS ROAD           | 36,037                | 5/1/96               | 0.1757%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| MRH                     | 0601110806      | DOS REIS ROAD           | 26,752                | 4/17/98              | 0.7070%                    | -1.8267                  | 24,752                            | 17.6                             | 1,302                     | 0.0526                       | No          |
| MRH                     | 0601110807      | DOS REIS ROAD           | 26,906                | 4/17/98              | 0.6234%                    | -1.8267                  | 24,752                            | 17.6                             | 1,302                     | 0.0526                       | No          |
| MRH                     | 0601110808      | DOS REIS ROAD           | 25,300                | 4/17/98              | 0.6858%                    | -1.8267                  | 24,752                            | 17.6                             | 1,302                     | 0.0526                       | No          |
| MRH                     | 0601110809      | MOSSDALE                | 26,465                | 4/16/98              | 0.5217%                    | -1.8267                  | 24,923                            | 17.6                             | 928                       | 0.0372                       | No          |
| MRH                     | 0601110810      | MOSSDALE                | 25,264                | 4/16/98              | 0.4015%                    | -1.8267                  | 24,923                            | 17.6                             | 928                       | 0.0372                       | No          |
| MRH                     | 0601110811      | MOSSDALE                | 25,926                | 4/16/98              | 0.7143%                    | -1.8267                  | 24,923                            | 17.6                             | 928                       | 0.0372                       | No          |
| MRH                     | 062642          | MOSSDALE                | 25,194                | 4/19/99              | 1.3337%                    | 1.1031                   | 6,914                             | 65.3                             | 2,763                     | 0.3996                       | No          |

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|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|----------------------------------|---------------------------------|---------------------------|-----------------------------|-------------|
| MRH                     | 062643          | MOSSDALE                | 25,204                | 4/19/99              | 1.1974%                    | 1.1031                   | 6,914                            | 65.3                            | 2,763                     | 0.3996                      | No          |
| MRH                     | 062644          | MOSSDALE                | 25,921                | 4/19/99              | 1.5863%                    | 1.1031                   | 6,914                            | 17.6                            | 2,763                     | 0.3996                      | No          |
| MRH                     | 062645          | DOS REIS ROAD           | 25,267                | 4/19/99              | 2.2512%                    | 1.1031                   | 6,914                            | 17.6                            | 2,763                     | 0.3996                      | No          |
| MRH                     | 062646          | DOS REIS ROAD           | 25,092                | 4/19/99              | 2.1422%                    | 1.1031                   | 6,914                            | 17.6                            | 2,763                     | 0.3996                      | No          |
| MRH                     | 064723          | MOSSDALE                | 25,531                | 5/19/06              | 0.0273%                    | -1.4369                  | 24,556                           | 66.6                            | 6,734                     | 0.2742                      | No          |
| MRH                     | 064606          | MOSSDALE                | 25,746                | 4/20/99              | 0.8866%                    | 1.1031                   | 6,920                            | 17.6                            | 2,823                     | 0.4079                      | No          |
| MRH                     | 064584          | DURHAM FERRY            | 25,230                | 5/9/05               | 0.0213%                    | -1.2566                  | 8,866                            | 60.8                            | 2,443                     | 0.2756                      | No          |
| MRH                     | 064585          | DURHAM FERRY            | 25,229                | 5/9/05               | 0.0000%                    | -1.2566                  | 8,866                            | 60.8                            | 2,443                     | 0.2756                      | No          |
| MRH                     | 064586          | DURHAM FERRY            | 25,231                | 5/9/05               | 0.0098%                    | -1.2566                  | 8,866                            | 60.8                            | 2,443                     | 0.2756                      | No          |
| MRH                     | 064587          | DURHAM FERRY            | 25,229                | 5/9/05               | 0.0000%                    | -1.2566                  | 8,866                            | 60.8                            | 2,443                     | 0.2756                      | No          |
| MRH                     | 064589          | DOS REIS ROAD           | 25,052                | 5/10/05              | 0.0436%                    | -1.2566                  | 8,982                            | 61.5                            | 2,628                     | 0.2926                      | No          |
| MRH                     | 064590          | DOS REIS ROAD           | 25,506                | 5/10/05              | 0.0000%                    | -1.2566                  | 8,982                            | 61.5                            | 2,628                     | 0.2926                      | No          |
| MRH                     | 064591          | DOS REIS ROAD           | 24,946                | 5/3/05               | 0.0000%                    | -1.2566                  | 8,192                            | 61.2                            | 2,446                     | 0.2986                      | No          |
| MRH                     | 064672          | DURHAM FERRY            | 25,174                | 5/2/05               | 0.0490%                    | -1.2566                  | 8,140                            | 61.6                            | 2,412                     | 0.2963                      | No          |
| MRH                     | 064673          | DURHAM FERRY            | 25,176                | 5/2/05               | 0.0130%                    | -1.2566                  | 8,140                            | 61.6                            | 2,412                     | 0.2963                      | No          |
| MRH                     | 064674          | DURHAM FERRY            | 25,192                | 5/2/05               | 0.0121%                    | -1.2566                  | 8,140                            | 61.6                            | 2,412                     | 0.2963                      | No          |
| MRH                     | 064675          | DURHAM FERRY            | 25,170                | 5/2/05               | 0.0000%                    | -1.2566                  | 8,140                            | 61.6                            | 2,412                     | 0.2963                      | No          |
| MRH                     | 064697          | DOS REIS ROAD           | 25,186                | 5/3/05               | 0.0000%                    | -1.2566                  | 8,192                            | 61.2                            | 2,446                     | 0.2986                      | No          |
| MRH                     | 064698          | DOS REIS ROAD           | 26,090                | 5/3/05               | 0.0309%                    | -1.2566                  | 8,192                            | 61.2                            | 2,446                     | 0.2986                      | No          |
| MRH                     | 064699          | DOS REIS ROAD           | 25,417                | 5/10/05              | 0.0043%                    | -1.2566                  | 8,982                            | 61.5                            | 2,628                     | 0.2926                      | No          |
| FRH                     | 063114          | DOS REIS ROAD-FRH       | 53,122                | 4/20/89              | 0.1605%                    | 0.0452                   | 1,813                            | 66.3                            | 10,781                    | 5.9456                      | No          |
| FRH                     | 0601140105      | STEWART ROAD-FRH        | 54,545                | 4/17/90              | 0.0174%                    | -0.0443                  | 1,107                            | 69.7                            | 9,663                     | 8.7328                      | No          |
| FRH                     | 0601140106      | STEWART ROAD-FRH        | 53,641                | 4/17/90              | 0.0108%                    | -0.0443                  | 1,107                            | 69.7                            | 9,663                     | 8.7328                      | No          |
| FRH                     | 0601140107      | DOS REIS ROAD-FRH       | 53,367                | 4/16/90              | 0.0412%                    | -0.0443                  | 1,087                            | 69.7                            | 9,468                     | 8.7106                      | No          |

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|-------------------------|-----------------|-------------------------|-----------------------|----------------------|----------------------------|--------------------------|----------------------------------|---------------------------------|---------------------------|-----------------------------|-------------|
| FRH                     | 0601140108      | DOS REIS ROAD-FRH       | 54,179                | 4/16/90              | 0.0286%                    | -0.0443                  | 1,087                            | 69.7                            | 9,468                     | 8.7106                      | No          |
| FRH                     | 0601140110      | DOS REIS ROAD-FRH       | 54,050                | 5/2/90               | 0.0290%                    | -0.0443                  | 1,348                            | 70.7                            | 3,374                     | 2.5035                      | No          |
| FRH                     | 0601140111      | DOS REIS ROAD-FRH       | 54,745                | 5/2/90               | 0.0826%                    | -0.0443                  | 1,348                            | 70.7                            | 3,374                     | 2.5035                      | No          |
| FRH                     | 0601140112      | STEWART ROAD-FRH        | 54,334                | 5/3/90               | 0.0149%                    | -0.0443                  | 1,364                            | 71.8                            | 3,604                     | 2.6423                      | No          |
| FRH                     | 0601140113      | STEWART ROAD-FRH        | 54,006                | 5/3/90               | 0.0103%                    | -0.0443                  | 1,364                            | 71.8                            | 3,604                     | 2.6423                      | No          |
| FRH                     | 0601140114      | DOS REIS ROAD-FRH       | 55,408                | 4/15/91              | 0.0994%                    | 0.8465                   | 694                              | 64.7                            | 8,009                     | 11.5343                     | No          |
| FRH                     | 0601140115      | DOS REIS ROAD-FRH       | 54,081                | 4/15/91              | 0.1455%                    | 0.8465                   | 694                              | 64.7                            | 8,009                     | 11.5343                     | No          |
| FRH                     | 0601140212      | STEWART ROAD-FRH        | 72,798                | 4/7/92               | 0.1507%                    | -1.2290                  | 1,586                            | 66.6                            | 5,852                     | 3.6904                      | No          |
| FRH                     | 0601140213      | STEWART ROAD-FRH        | 54,087                | 4/7/92               | 0.1001%                    | -1.2290                  | 1,586                            | 66.6                            | 5,852                     | 3.6904                      | No          |
| FRH                     | 0601140214      | STEWART ROAD-FRH        | 55,644                | 4/13/92              | 0.0472%                    | -1.2290                  | 1,383                            | 66.4                            | 1,429                     | 1.0332                      | No          |
| FRH                     | 0601140215      | STEWART ROAD-FRH        | 51,830                | 4/13/92              | 0.0376%                    | -1.2290                  | 1,383                            | 66.4                            | 1,429                     | 1.0332                      | No          |
| FRH                     | 0601140306      | STEWART ROAD-FRH        | 53,499                | 4/6/93               | 0.0833%                    | -1.5854                  | 3,016                            | 65.1                            | 7,048                     | 2.3370                      | No          |
| FRH                     | 0601140312      | STEWART ROAD-FRH        | 56,650                | 4/28/93              | 0.2546%                    | -1.5854                  | 4,392                            | 63.8                            | 1,756                     | 0.3998                      | No          |
| FRH                     | 063135          | STEWART ROAD-FRH        | 52,729                | 5/4/93               | 0.2925%                    | -1.5854                  | 4,568                            | 62.8                            | 1,850                     | 0.4050                      | No          |
| FRH                     | 063138          | STEWART ROAD-FRH        | 54,357                | 5/12/93              | 0.2384%                    | -1.5854                  | 3,566                            | 63.6                            | 1,823                     | 0.5112                      | No          |
| FRH                     | 0601140315      | STEWART ROAD-FRH        | 53,665                | 4/11/94              | 0.2100%                    | 0.3167                   | 1,462                            | 66.3                            | 2,030                     | 1.3882                      | No          |
| FRH                     | 0601140412      | DOS REIS ROAD-FRH       | 52,313                | 4/17/95              | 1.0025%                    | -0.7578                  | 18,871                           | 57.8                            | 3,790                     | 0.2008                      | No          |
| FRH                     | 0601140414      | STEWART ROAD-FRH        | 51,511                | 4/17/95              | 0.8679%                    | -0.7578                  | 18,871                           | 57.8                            | 3,790                     | 0.2008                      | No          |
| FRH                     | 0601140501      | STEWART ROAD-FRH        | 51,886                | 4/17/95              | 0.8638%                    | -0.7578                  | 18,871                           | 57.8                            | 3,790                     | 0.2008                      | No          |
| FRH                     | 0601140504      | STEWART ROAD-FRH        | 53,444                | 5/17/95              | 0.8267%                    | -0.7578                  | 23,030                           | 67.1                            | 3,514                     | 0.1526                      | No          |
| FRH                     | 063147          | DOS REIS ROAD-FRH       | 52,676                | 5/5/95               | 1.1813%                    | -0.7578                  | 20,981                           | 62.8                            | 3,904                     | 0.1861                      | No          |
| FRH                     | 063148          | STEWART ROAD-FRH        | 53,342                | 5/17/95              | 0.6320%                    | -0.7578                  | 23,030                           | 67.1                            | 3,514                     | 0.1526                      | No          |
| FRH                     | 063149          | DOS REIS ROAD-FRH       | 52,935                | 5/5/95               | 0.8782%                    | -0.7578                  | 20,981                           | 62.8                            | 3,904                     | 0.1861                      | No          |
| FRH                     | 063150          | STEWART ROAD-FRH        | 52,719                | 5/5/95               | 0.6268%                    | -0.7578                  | 20,981                           | 62.8                            | 3,904                     | 0.1861                      | No          |

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|-------------------------|-----------------|--------------------------|-----------------------|----------------------|----------------------------|--------------------------|-----------------------------------|----------------------------------|---------------------------|------------------------------|-------------|
| FRH                     | 063151          | STEWART ROAD-FRH         | 52,689                | 5/5/95               | 0.5834%                    | -0.7578                  | 20,981                            | 62.8                             | 3,904                     | 0.1861                       | No          |
| FRH                     | 0601060114      | STEWART ROAD-FRH         | 51,620                | 4/15/96              | 0.1534%                    | -0.3387                  | 6,701                             | 60.4                             | 2,668                     | 0.3981                       | No          |
| FRH                     | 0601060115      | STEWART ROAD-FRH         | 52,780                | 4/15/96              | 0.2546%                    | -0.3387                  | 6,701                             | 60.4                             | 2,668                     | 0.3981                       | No          |
| FRH                     | 0601060201      | STEWART ROAD-FRH         | 52,570                | 4/30/96              | 0.0651%                    | -0.3387                  | 6,525                             | 65.3                             | 1,953                     | 0.2993                       | No          |
| FRH                     | 0601060205      | STEWART ROAD-FRH         | 51,744                | 4/30/96              | 0.1094%                    | -0.3387                  | 6,525                             | 65.3                             | 1,953                     | 0.2993                       | No          |
| FRH                     | 0601140505      | SAN JOAQ.R,BELOW OLD-FRH | 51,660                | 4/17/96              | 0.3206%                    | -0.3387                  | 6,847                             | 59.6                             | 1,743                     | 0.2546                       | No          |
| FRH                     | 0601060110      | DOS REIS ROAD-FRH        | 51,347                | 5/1/96               | 0.0519%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| FRH                     | 0601060111      | SAN JOAQ.R,BELOW OLD-FRH | 51,100                | 5/2/96               | 0.0917%                    | -0.3387                  | 6,433                             | 65.1                             | 1,821                     | 0.2831                       | No          |
| FRH                     | 0601060112      | SAN JOAQ.R,BELOW OLD-FRH | 52,010                | 5/2/96               | 0.1127%                    | -0.3387                  | 6,433                             | 65.1                             | 1,821                     | 0.2831                       | No          |
| FRH                     | 0601060203      | DOS REIS ROAD-FRH        | 51,951                | 5/1/96               | 0.1163%                    | -0.3387                  | 6,459                             | 65.3                             | 1,798                     | 0.2784                       | No          |
| FRH                     | 0601060505      | MOSSDALE-FRH             | 15,796                | 4/23/98              | 0.1006%                    | 0.6102                   | 20,562                            | 65.8                             | 2,233                     | 0.1086                       | No          |
| FRH                     | 0601060506      | MOSSDALE-FRH             | 18,670                | 4/23/98              | 0.0630%                    | -1.8267                  | 20,562                            | 65.8                             | 2,233                     | 0.1086                       | No          |
| FRH                     | 0601140606      | DOS REIS ROAD-FRH        | 24,377                | 4/24/98              | 0.1651%                    | -1.8267                  | 20,104                            | 65.7                             | 2,240                     | 0.1114                       | No          |
| FRH                     | 0601140607      | DOS REIS ROAD-FRH        | 24,787                | 4/24/98              | 0.2653%                    | -1.8267                  | 20,104                            | 65.7                             | 2,240                     | 0.1114                       | No          |
| FRH                     | 0601060414      | MOSSDALE-FRH             | 21,714                | 5/6/98               | 0.6211%                    | -1.8267                  | 16,506                            | 65.7                             | 2,161                     | 0.1309                       | No          |
| FRH                     | 0601060415      | MOSSDALE-FRH             | 21,486                | 5/6/98               | 0.4147%                    | -1.8267                  | 16,506                            | 65.7                             | 2,161                     | 0.1309                       | No          |